

*effusa* (Sw.) Urban and *D. exculpta squamifera* C. Chr., of Costa Rica, but it differs strongly in its stout shaggy stipes and rachises, deltoid non-attenuate blades, minutely paleaceous segments, and large coriaceous indusia. In color and texture it recalls *D. macrostegia* (Hook.) Kuntze and *D. amplissima* (Presl) C. Chr., of South America, belonging to the subgenus *Polystichopsis*.

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## Fern Ecology of Barro Colorado Island Panama Canal Zone

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Barro Colorado Island is the largest island in Gatun Lake, the artificial lake formed in 1914 to make up the central portion of the Panama Canal. Its highest elevation is 537 feet. In 1923 the island was set aside by the governor of the Canal Zone as a biological reserve. Subsequently a commodious and comfortable laboratory was erected on it. It has been visited by numerous biologists, who find in its six square miles of forested area and along its twenty-five miles of shore line a wealth of material for research in tropical biology.

The region is a tropical rain forest of a somewhat dry type, i. e. including a number of periodic or monsoon plant types. The annual rainfall is close to 115 inches. Half the area of the island is primeval forest, the remainder being second growth, with only an occasional small clearing.

Mr. Paul C. Standley (The ferns of Barro Colorado Island. AMERICAN FERN JOURNAL 16: 112-120; 17: 1-8. 1926, 1927) lists forty-four species of ferns and fern allies from the island. The writer by collections made during July and August added twenty-eight others, giv-



ing seventy-two in all. Determinations were made by Dr. William R. Maxon of the U. S. National Herbarium. The increase in the list is due in part to the extension of trails, there being now about thirty kilometers of trails, permitting access to almost every part of the island. It is also partly due to the opportunity for more intensive study. Eighteen of the added forms were collected within one kilometer of the laboratory. At the ravine crossing of one of the older trails, within 100 meters of the laboratory, were found eight previously unreported forms including a tree fern and a filmy fern. Up to the very end of the writer's stay, visits to new ravines revealed undiscovered species. So it is probable that the number will reach at least one hundred, which is a very good showing for a lowland tropical area.

#### CLEARINGS

Very few ferns are found on clearings. The most characteristic is *Lygodium polymorphum*, which climbs freely over weeds and shrubs. On a few exposed clearings along the shore may be seen the snowy *Pityrogramma calomelaena*, the thicket-forming gleicheniaceous *Dicranopteris flexuosa*, or the coarse mat-forming club-moss, *Lycopodium cernuum*.

#### PIONEER FOREST

The absence of big trees would seem to indicate that the greater part of the eastern half of the island was in cultivation up to about fifty years ago. Apparently the commonest ferns here are the tall pinnate *Cyclopeltis semicordata* and the rather low but coarse *Tectaria martinicensis*. Several species of *Adiantum*, especially *A. petoliatum* and *A. lucidum*, are frequent, and there are also invaders from the climax forest. Epiphytic ferns



are beginning to occupy the tree trunks and branches. *Lygodium polymorphum* has been replaced largely by *L. radiatum*, which climbs to considerable heights.

### CLIMAX FOREST

The climax forest occupies the whole western half of the island. A walk of a kilometer on the trails brings one in sight of about 250 trees having a trunk diameter equaling or exceeding 0.6 m. (2 feet). Ferns constitute a prominent part of the undergrowth. On the forest floor, outside of the ravines, the largest forms are *Cyclopettis semicordata* and *Diplazium grandifolium*, which have pinnate fronds attaining a height of about a meter. *Adiantum* is a ubiquitous genus, including *A. petiolatum*, *A. lucidum*, *A. villosum* and *A. obliquum*. *Pteris propinqua* frequently lifts its large ternate leaf somewhat suggestive of *Pteridium aquilinum*. Other species are *Pteris pungens*, *Asplenium falcinellum*, *Diplazium grandifolium*, *Diplazium delitescens*, *Dictyoxiphium panamense*, *Dryopteris dentata* (Standley's paper), *Dryopteris Poiteana*, *Maxonia apiifolia*, and *Tectaria martinicensis*. *Selaginella haematodes*, with its bright red stems, is occasional and *Selaginella conduplicata* frequent in the forest.

### RAVINES

Ravines are par excellence the home of ferns. Here are found two interesting tree ferns. *Alsophila tenerifrons* attains a height of ten meters and a trunk diameter of 0.2 m. *Hemitelia petiolata* is a graceful form three or four meters high. *Danaea nodosa*, the only marattiaceous fern noted, is said by Standley to be common in ravines, but the writer found it only on the banks of a ravine in the Shannon Trail. It is a tall coarse fern with swollen nodes on the rhachis. *Cyclo-*



*peltis semicordata* is particularly abundant on ravine banks, forming an almost pure stand in places. *Pteris grandifolia* is the largest polypodiaceous fern, having a once pinnate leaf four meters in length. *Dennstaedtia rubiginosa* has a thrice pinnate leaf. *Dryopteris Sprengelii* has a short upright trunk suggestive of the tree ferns. The three last forms were found only in a deep ravine crossed by the Pearson Trail about a kilometer from the laboratory. *Dryopteris sordida*, found very near the laboratory, had not before been reported for any locality south of Guatemala. *Saccoloma elegans* is a unique type with sporangia in pockets along the margins of the leaflets of the once pinnate leaves. *Leptochilus cladorrhizans* has the interesting habit of forming slender rooting runners from the tip of the frond. Other ravine ferns are *Pteris Kunzeana*, *Asplenium laetum*, *Tectaria euryloba*, and *Hemidictyum marginatum*. On the rocky walls of a deep narrow ravine where the light was very diffuse was found *Trichomanes diversifrons*, a fine large plant of the *Hymenophyllaceae*.

#### ERODING SHORES

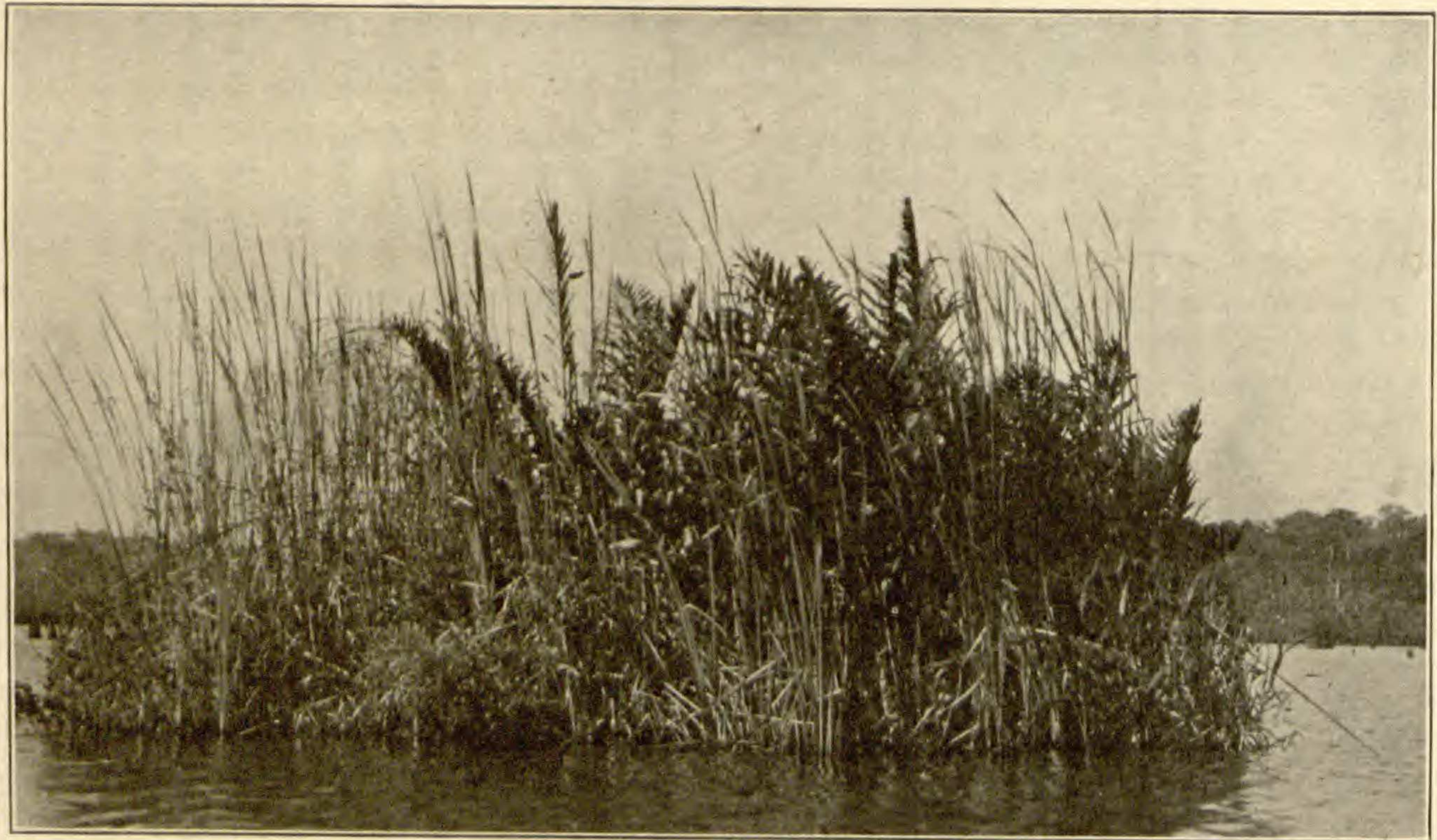
*Dicranopteris flexuosa*, one of the *Gleicheniaceae*, and the rankly growing *Lycopodium cernuum* are associated on exposed shores forming a dense tangle. The only locality noted for *Alsophila microdonta* is of similar character. The most xeric form of the region is probably *Pityrogramma calomelaena*. It is snowy white underneath, suggesting the temperate *Notholaena dealbata*, and is found on sunny clay banks and dry rock cliffs. *Selaginella Fendleri* is found on some of the semi-exposed shores. In more sheltered situations on overhanging rocks may be seen *Nephrolepis pendula*, a long drooping form closely allied to the well-known Boston





AN EXPOSED LAKE BLUFF, COVERED PRINCIPALLY WITH *DICRANOPTERIS FLEXUOSA*, A GLEICHENIACEOUS FERN. IN THE LOWER LEFT CORNER IS THE TREE FERN, *ALSOPHILA MICRODONTA*.





ACROSTICHUM DANEAEFOLIUM GROWING WITH THE CAT TAIL (*TYPHA ANGUSTIFOLIA*) ON A SMALL SUBMERGED ISLAND IN GATUN LAKE ON THE SIDE OF BARRO COLORADO ISLAND OPPOSITE THE CANAL.



Fern. Associated with it were *Blechnum occidentale* and *Polypodium percussum*.

#### WATER AND SWAMP

The only water fern, *Salvinia auriculata*, occurs floating on some of the still bays on the south and west sides of the island. The most conspicuous and widespread of the marsh ferns is *Acrostichum daneaeifolium* with very coarse pinnate leaves one to two meters in height. Pure associations of this fern were noted in the Canal Zone, but around Barro Colorado island it is found mainly along shores and on little submerged islands associated with *Typha angustifolia* and other aquatics, in a characteristic hydrarch pioneer association. With it may frequently be found *Dryopteris serrata*, *D. gongylodes*, and *Nephrolepis biserrata*.

#### EPIPHYTES

In the epiphytic flora ferns figure very conspicuously. There are two fairly well-marked groups,—those with clustered fronds and those with fronds scattered along an extensively trailing rhizome. Among the former the prominent genus is *Polypodium*, recognized by the round fruit dots without indusium. *P. phyllitidis*, in aspect similar to a bird's-nest fern, is frequent, although previously unreported. *P. crassifolium* has the most extremely xeric leaf. Leaves of this plant lay for a month in the hot dry attic of the laboratory before withering commenced. Other species are *P. percussum* (occasional), *P. costaricense* (very common on trunks and branches), and an unidentified species of the *P. pectinatum* group. *Asplenium serratum*, the American birds'-nest fern, is a frequent and beautiful form. Also very frequent is *Eschatogramme furcata* with its interesting staghorn-like fronds. *Nephrolepis pendula* is



found hanging from horizontal branches high in the larger trees. *Vittaria lineata* has very long slender leaves which, tufted like grass clumps, hang from the branches in the forest. *Ananthacorus angustifolius* has similar but shorter and broader leaves. *Anetium citrifolium* has a characteristic simple obovate leaf. Several filmy ferns, small species of *Trichomanes*, grow on the bark of trees. *T. sphenodes* was collected by the writer, and *T. Godmani* as well as *T. Krausii* were noted by Standley. *Elaphoglossum Herminieri* is mentioned by Standley as an infrequent but conspicuous epiphyte. A single specimen of *Lycopodium dichotomum* was collected beneath a large tree from which it had fallen.

Of the ferns which have rhizomes extensively trailing or climbing upon tree-trunks, the most common is *Stenochlaena vestita*, with strongly differentiated foliage leaves and sporophylls. *Polypodium ciliatum* covers a considerable part of a large tree-trunk with its vine-like growth. Others are *Maxonia apiifolia*, *Leptochilus nicotianaefolius*, *Polybotrya villosula*, *P. osmundacea*, and *P. caudata*. The first three were collected by the writer as previously unreported forms, and the last two were noted by Standley but not by the writer. The trunk of a tree fern furnishes an especially good habitat for such forms.

The flooding of the Gatun Lake area has called forth new adjustments along the shore lines. The establishment of exposed shore pioneers along the eroding shores has already been mentioned. Trees which were killed by flooding were, of course, originally occupied by epiphytic ferns. Most of these have died, due to peeling of the bark and to insolation. Only the more hardy forms have persisted, the most frequent being *Nephrolepis pendula*, *Vittaria lineata*, *Polypodium phyllitidis* and *P. crassifolium*. Water and marsh ferns have



invaded the area, occupying stumps which come to or nearly to the water surface. On certain of the higher stumps may be found almost an intermingling of these forms with the surviving epiphytes.

### SUMMARY

1. Barro Colorado Island in the lowland tropical rain forest of the Panama Canal Zone has 72 known species of ferns and fern allies.

2. Very few of these species figure as clearing pioneers.

3. Ferns are frequent in second growth forest and abundant in primeval forest as underherbs, none of the upland forms being more than about one meter high.

4. Terrestrial ferns are most abundant in the ravines, where the flora includes two rather plentiful tree ferns.

5. A group of fern species is characteristic of the marsh formations in Gatun Lake.

6. There are numerous epiphytic ferns of both the tufted and the trailing types. Some of these are sufficiently resistant to persist on the exposed dead stumps in the lake.

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## Collecting Horsetails along the Way<sup>1</sup>

JOHN H. SCHAFFNER

The summer of 1927 was spent in taking a camping trip with my family to the Yellowstone National Park and although the main purpose was merely recreation and sight-seeing some botanizing was done and my special friends, the Equisetums, received their proper share of attention. Controlling the steering-wheel of an

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<sup>1</sup> Papers from the Department of Botany, The Ohio State University. No. 208.